2.0 EMERGENCY ACTIONS UNDERTAKEN

2.1 Introduction

DOE's emergency response to the threat of the Cerro Grande Fire began with certain preventive actions undertaken immediately before the wildfire entered LANL boundaries in early May 2000. These actions, as well as subsequent actions, were taken by DOE, by UC and its subcontractors, or by other government agencies and their contractors and subcontractors at DOE's request or as a result of funding from DOE. These actions included fire suppression and control activities (such as creating firebreaks and dropping water and fire-retardant slurry), both over large areas of the LANL facility and within specific watersheds, to protect human lives and government property. Immediately after the fire, DOE initiated other actions to address the extreme potential for storm water flooding and other storm water damages at LANL and properties downstream from LANL. These actions were taken to address threats to human lives and to properties and to support the safe reoccupancy of LANL facilities by UC and its subcontractor workers.

The prescribed burn was ignited on May 4, 2000, and was declared to be a wildfire less than 24 hours later on May 5. Firefighter crews then began to conduct various fire line operations, including the setting of backfires and the clearing of narrow firebreaks using handheld tools as well as heavy machinery wherever possible. Aircraft dropped fire-retardant slurry and water loads in an effort to bring the wildfire under control over the next couple of days. Some of these actions occurred on land along SR 501 that is administered by the DOE as part of the LANL facility. Through a cooperative arrangement between the Forest Service and DOE, the Forest Service has permission to freely access property under their administration via various forest access roads that originate at SR 501 and cross the narrow belt of DOE-administered land. Firefighters would have used some of these roads to reach areas of the Santa Fe National Forest that were on fire. Additionally, it would have been difficult for firefighters to distinguish the boundary fences in some areas along this strip of land; under the emergency circumstances they likely made the assumption that all land west of SR 501 was Forest Service-administered property and conducted firefighting measures on this land accordingly. On May 7, the fire jumped east of the main fire line and was driven by high winds across the upper portions of Water and Pajarito Canyons, Cañon de Valle, and as far north as the edge of Los Alamos Canyon. Back fires were set along sections of SR 501, including within the LANL boundary.

DOE's subsequent actions include those taken to suppress the fire while it burned within LANL's TAs. By the next day (May 8), fires were spotting within the edges of several TAs, particularly within TA-16, which is located on the east side of SR 501. Firefighters quickly extinguished the spot fires before they could consume very much vegetation or result in major facility damage. Slurry drops (Photo 2.1) in advance of the front line were increased, and bulldozers were used to blade firebreaks within LANL boundaries. On May 9, the fire continued to spot within the edges of LANL's TAs and these spot fires were quickly controlled. Firefighters applied fire-retardant foam products to protect LANL facilities in addition to continuing the other fire suppression actions already on-going. However, winds the next day (May 10) carried fire far in front of the main fire front deep into both LANL and the Los Alamos townsite. Hopes of immediately containing the fire were gone, and the fire rampaged for several days but then abated.

PHOTO 2.1—*Slurry Being Dropped*

The Cerro Grande Fire was considered to be contained within LANL by May 22 and in total control by June 7. Spot fires would continue to flare up "within the black" (that is, within the area encompassed by the fire's perimeter) for yet another six weeks before finally becoming extinguished.

The remainder of this section, and subsequent analyses presented later in this report, discuss DOE activities specific to fire suppression actions and to post-fire actions. Actions are further grouped according to their general LANL-wide applications (which includes general fire suppression actions in Rendija Canyon although this land is not part of the LANL reserve) or by canyon-specific locations within general watersheds where that identification is important to understanding the impacts of the activities. In this report, the watersheds are defined by the canyons that join together to empty into the Rio Grande at a single point (Table 2.1), rather than by the more detailed fashion described and employed in the 1999 LANL SWEIS analyses (DOE 1999). To this end, five watersheds are identified (Figure 2.1) where actions were conducted. Actions discussed later may also be grouped in terms of LANL facility reoccupation activities or soil erosion and storm water control and damage reduction activities.

TABLE 2.1—*Watersheds Where Actions were Conducted*

Watershed Designation	Canyons Included in Watershed Designation
Los Alamos Canyon	Los Alamos Canyon, DP Canyon, Pueblo Canyon, Acid Canyon, Bayo Canyon, Rendija Canyon, Guaje Canyon
Pajarito Canyon	Pajarito Canyon, Two Mile Canyon, Three Mile Canyon
Mortandad Canyon	Mortandad Canyon, Cañada del Buey, Ten-Site Canyon
Water Canyon	Water Canyon, Potrillo Canyon, Fence Canyon, Cañon de Valle
Sandia Canyon	Sandia Canyon

2.2 Fire Suppression Actions

Fire suppression and control actions included actions taken within LANL boundaries and within a DOE-administered tract located in Rendija Canyon. Actions were undertaken by firefighters specializing in both structural and wildland fires. These firefighters were from various local and regional areas and represented a wide variety of city, county, state, federal, and pueblo government organizations as well as small communities and other neighborhood organizations. Most of these actions occurred over large areas at LANL. Soil-disturbing activities are discussed later by watershed.

2.2.1 LANL-wide Fire Suppression Activities

Activities undertaken during the fire suppression period involved numerous LANL-wide locations. At the peak of the firefighting efforts, a total of about 1,600 firefighters and 100 pieces of firefighting equipment were present in the LANL vicinity performing fire suppression activities. The firefighters used nine sites around LANL for activity and equipment staging purposes. Each of these sites was less than 1.0 ac (0.4 ha) in size. With one exception, they were in previously disturbed or developed areas. Additionally, firefighters used the existing Fire Equipment Cache Facility (Cache Facility) site located at LANL's TA-49. The Cache Facility was also used as a rest and recovery site for the firefighters. About 550 firefighters ate, rested, and slept at this 58 ac (23 ha) site during the peak fire suppression period.

Trees were cut using chain saws and hand axes at many locations at LANL (Photo 2.2). Firefighters felled trees to remove the fire's fuel sources near buildings, structures (including aboveground utility lines, such as electric lines, pole structures, and gas mains), access roadways, and other locations where fuel removal was deemed necessary to facilitate the firefighting goals of life and property protection. The trees were later collected by LANL staff or subcontractor staff and removed by truck from the sites where they were felled. The trees were stockpiled at various locations and will eventually undergo routine LANL processing for disposal. The disposal process generally entails chipping the trees into mulch for reuse on site; entering the excess property disposal system to designate trees for release to the public; or, if the trees are contaminated with radioactive material, disposal at LANL's low-level radioactive waste site at TA-54.

To control the advance of the fire front, firefighters constructed numerous, narrow fuel breaks to remove fuel sources (Figure 2.2). Trees, bushes, and grasses were removed with rakes, axes, chain saws, and other similar hand tools. Typically, the fuel breaks created by hand tools were less than 10 ft (3 m) in width and involved only minor soil disturbance.

PHOTO 2.2—*Firefighter Felling Burned Tree*

Once fuel breaks had been established, the firefighters ignited several back fires if conditions were favorable. The back fires burned from the fuel break back towards the fire front creating a larger area without fuel to help control the fire's spread. Back fires were ignited with matches or with handheld torches that use small canisters filled with a flammable material.

Helicopters with underslung drop buckets flew close to the tree top level at LANL and neighboring areas and dropped water on the fire (Photo 2.3). The drop buckets were filled from various water sources including a permanent 5,000-gallon (gal.) (18,950-liter [l]) fill tank located at LANL's TA-49 expressly for such use, the Los Alamos Reservoir, and the Rio Grande. Temporary portable 3,000-gal. (11,370-l) "pumpkin tanks" were brought to LANL and set up at TA-8 and TA-52 to supply helicopters with water to fight fires within the LANL boundary. The helicopters used the helipad at TA-49, the Los Alamos Airport, and the Santa Fe Airport for various staging and refueling purposes.

Airplanes also dropped fire-retardant slurry on the forest in advance of the fire front (see Photo 2.1, page 2-2). The slurry was composed of an ammonium polyphosphate solution (with trace amounts of sodium ferrocyanide), which acts both to reduce the flammability of the trees and other fuel sources that it settles upon and as a post-fire fertilizer to help the forest recover after it has burned. These airplanes flew just above tree level over LANL and adjacent forest areas and mostly used the Albuquerque International Airport for staging and refueling purposes, although some of the smaller planes were able to use the Los Alamos and Santa Fe Airports as well.

Fire retardants in the form of foams were applied by handheld applicators and by truck-mounted applicators to buildings and structures, especially within the LANL TAs located along Pajarito Road and adjacent roads (see Figure 1.4, page 1-15). The foam was

PHOTO 2.3—*Helicopter Dropping Muddy Water on Fire*

composed of a phosphate-based material, which acts to reduce the flammability properties of fuel sources.

UC staff and various regulatory agencies continued air monitoring and sampling actions throughout the fire suppression period. These activities used existing LANL air monitors and portable monitors brought to the site.

2.2.2 Watershed-specific Fire Suppression Activities

Some activities undertaken during the fire suppression period were specific to various watershed locations within LANL boundaries (see Figure 2.1, page 2-3). These ground-disturbing activities included using heavy machinery, such as bulldozers, to establish firebreaks by blading areas free of vegetation, to create new fire access roads and to improve existing roads so that the roads could be used by heavy transport equipment and fire trucks. These activities are described by their watershed location in Table 2.2. Professional archeologists and other environmental professionals participated in the planning and performance of the tasks to avoid disturbance of cultural and natural resources to the greatest practicable extent.

A smoldering subsurface fire at Material Disposal Area (MDA) R, a high explosive treatment area dating from the 1940s, was also suppressed. MDA-R is located within TA-16 along the south side of the upper rim of Cañon de Valle. Limited characterization of the area had been performed in the past and it was known that residues of explosives materials (including TNT) and heavy metals (including barium, cobalt, lead, silver, and zinc) were present in the waste material, as were railroad ties and other flammable woods and wood products. The landfill started smoldering on about May 10. The work performed to extinguish this subsurface fire involved several days of slow saturation of the site with water and site monitoring, including air sampling. When suppression was unsuccessful through saturation of the disposal area, a remote robotic excavator was placed into the smoldering debris to excavate the debris, move it to a clear area, and douse it with water. Almost the entire MDA was excavated by the time the fire was completely extinguished. The work to remove the remainder of the waste at MDA-R will be undertaken later as part of an accelerated *Resource Conservation and Recovery Act* (RCRA) Corrective Action Process, which is subject to separate NEPA review.

TABLE 2.2—*Area (ac/ha) of Ground Disturbed at LANL during the Fire Suppression Period*

Activities	Total Area Disturbed* ac/ha	Area Disturbed within Watersheds				
		Water ac/ha	Pajarito ac/ha	Mortandad ac/ha	Los Alamos ac/ha	Sandia ac/ha
Firebreaks - bulldozer	97/39	30/12	11/4.4	21/8	0/0	0/0
Access Roads - new	51/20	6/2.4	42/17	0/0	3/1.2	0/0
Access Roads - improved	325/130	117/46	80/32	31/12	50/20	5/2

* Acreage total may include areas outside of the watersheds.

2.3 Post-fire Actions

Post-fire actions included actions taken to allow safe reoccupancy of LANL facilities; monitoring and assessment; establishment of staging areas; removal and stabilization of contaminants and other hazardous wastes and materials; erosion control; and storm water control. Most of these actions occurred over large areas at LANL. The larger storm water control projects and contaminant removal projects are discussed by watershed.

2.3.1 LANL-wide Post-fire Activities

Many of the post-fire activities were spread out over LANL, both within the areas that had been burned and over areas that had not burned. The activities described as being LANL-wide activities were taken and repeated at multiple locations and were mostly small in relative scale, and the direct and indirect impacts are limited to the areas in the immediate vicinity of the action itself.

Various material, work practices, and regulatory compliance standards were applied to implementing these activities. All post-fire actions at LANL that had the potential to affect historic properties or other cultural resources, or that had the potential to affect sensitive habitat of federally-listed T&E species, were planned and executed with the participation of professional archeologists and biologists employed by UC.

Additionally, for all post-fire actions that required soil-disturbing activities, the individual sites were subsequently recontoured and reseeded with appropriate site-specific seed mixes. Temporary soil erosion control measures, such as silt fences, were installed to protect the sites from storm water runon and runoff until seedlings have become established according to a Storm Water Pollution Prevention (SWPP) Plan that was developed for LANL actions and implemented. Activities employed a variety of standard practices such as spraying water to suppress fugitive dust, restricting vehicles to established roads, restricting vehicle fueling practices to appropriately established sites away from arroyos and drainages, removing the smallest amount of vegetation possible, limiting activities within wetlands to the extent possible, and prohibiting activities within flagged perimeters of archeological sites.

Facility Reoccupancy

Public access was discontinued within all canyon areas at LANL except for the use of Pajarito Road and East Jemez Road. Signs were erected to warn the public to keep out of low-lying land within LANL boundaries and to prohibit hiking within burned areas undergoing rehabilitation.

Many structures, such as transportainers, trailers, sheds, storage buildings, cooling towers, pump houses, and military shelters, were damaged or destroyed by the fire as it moved over LANL (Photos 2.4 and 2.5). A total of 40 structures were damaged beyond reasonable repair or destroyed outright (Table 2.3). Structures were removed using conventional heavy equipment, such as front-end loaders, which resulted in some soil disturbance. Debris was sampled for radioactive material, for substances regulated under RCRA and the *Toxic Substances Control Act*, and for NMED special waste constituents before their removal and disposal at permitted disposal sites. Recyclable nonradioactive and nonhazardous materials were segregated from waste materials as much as practicable. If recyclable materials could not be segregated, all waste was disposed of according to standard LANL waste management practices. At the site of each structure, a ground area of approximately 100 ft wide by 100 ft long by 2 ft deep (30 m by 30 m by 0.6 m) was disturbed during removal of the trailers and other similar structures.

TABLE 2.3—*LANL Structures Damaged or Destroyed by the Cerro Grande Fire*

TA	Structures
15	50, 239, 314, 329, 339, 371, 372, 374, 375
16	515, 516, 518, 519, 520, 524, 559, 578
40	40, 72, 73
56	86, 87, 121, 181, 241, 242, 325, 397
52	111
64	7, 9, 11, 12, 13, 15, 18, 19, 21, 23, 24

Many buildings across the LANL site required replacement of various filters, monitors, alarms, cables, and other facility health and safety features. Equipment and furnishings, such as computers and carpets, were damaged by smoke and fire and required replacement. Building electrical and communications lines, smoke detectors and fire protection systems, and other infrastructure components also required repair or replacement. About 200 structures, including office buildings, warehouses, transportables, process laboratories, and sheds, suffered varying degrees of damage. Of those, about 78 structures only required filter replacements and general custodial cleaning (walls, floors, and other internal and external cleanup). Water storage tanks and pipes, as well as treatment lines, were drained and flushed around LANL as needed.

Hazard trees[1] along LANL roads and those next to buildings, structures, parking areas, and walkways were cut and removed from the site. Tree cutting activities resulted in minor surface soil disturbance, primarily at the site of each tree during the tree removal process.

Monitoring and Assessments

Air, surface water, groundwater, soil, and produce monitoring has continued as part of the post-fire actions. Approximately 30 damaged air and surface water monitoring stations have been repaired or replaced. Concrete bumpers and other protective barriers have been installed around groundwater monitoring wells and other monitoring devices, as necessary, to provide protection to these structures from potential floods and damage by floating debris. New rain and stream flow gauges were installed or relocated (less than 10) as needed to monitor for flood conditions. In addition, many canyons (Los Alamos, Pueblo, Pajarito, Water, Cañada del Buey, Sandia, Potrillo, and Mortandad) were investigated to determine the movement or transport of contaminants through alluvial groundwater, surface water, ash flow, and sediments. Contaminant monitoring has been expanded, and additional air and groundwater monitoring stations have been installed within and outside of LANL boundaries. Baseline characterization activities have been, and continue to be, conducted in response to the Cerro Grande Fire. These activities are located outside of LANL in the Jemez Mountains, in Pueblo, Pajarito, Los Alamos, Mortandad, Water, and Sandia Canyons, Cañon de Valle, and Cañada del Buey, and on San Ildefonso Pueblo lands in Mortandad and Los Alamos Canyons. Characterization activities are also being conducted in the Rio Grande and Cochiti Reservoir. An in-stream water quality monitoring sampling station was installed in June 2000 at the Water Canyon confluence with the Rio Grande (one side of the sampling station's support lines is anchored within the boundaries of LANL's TA-70).

Cultural resource sites in drainage areas and floodplains are being assessed, and protection or stabilization activities have been initiated. Sites vulnerable to flooding such as the historic cabin at TA-18 (Photo 2.6) are the first priority in receiving the placement of storm water control measures. This action started in June 2000 and will continue until completed. Similarly, areas of potential habitat for federally-listed T&E species are undergoing evaluation. Evaluation efforts will extend beyond this summer's breeding season. No protection or stabilization activities are anticipated for these areas during the time frame encompassed by this SEA. Any actions required later will be the subject of separate NEPA compliance reviews.

Establishment of Staging Areas

Equipment and supply staging areas were sited and used across a number of locations near the work areas. These staging areas included those within developed areas and existing paved areas, as well as unpaved and undeveloped areas. Some soil disturbance resulted from the siting of some of the staging areas. Heavy equipment was placed at many of the staging areas. Equipment, such as a sandbagging machine, was brought in,

[1] Hazard trees are those that have been damaged and are a physical hazard to personnel or property.

installed, and operated on-site to facilitate the recovery activities. Supplies were brought in and staged until needed. Supplies included straw bales and wattles (long nylon mesh tubes filled with straw); rocks; wire mesh; wood, fiber, and straw mulches; jute matting material; stakes; and similar materials. Tools were also staged at some of these areas, such as rakes, hoes, and shovels. Staging areas for cut logs were also established at various locations, including TA-5 and TA-63.

PHOTO 2.6—*Concrete Barriers to Prevent Storm Water Damage at Historic Cabin*

Erosion Control

Burned area vegetative rehabilitation for soil erosion control across LANL included contour raking, seeding by hand and by air, mulching, and hydromulching (Figure 2.3). Technical descriptions of these treatments can be found in the Cerro Grande Fire BAER Report Specifications (BAER 2000). Moderately and severely burned areas were contour raked to break up the soil surface and to redirect and reduce water flow (Photo 2.7). The ground disturbance from raking was limited to the first few inches of the soil's surface. After raking, the areas were seeded by hand, by mechanical spreaders, or by small, low-flying aircraft. After seeding, straw mulch was spread by hand or by mechanical straw blowers (Photo 2.8). About 15,000 straw bales were used in the mulching. About 1,000 ac (400 ha) were raked, seeded, and mulched—about 350 ac (140 ha) seeded by hand and 650 ac (260 ha) by air. Hand work was begun in early June and completed in August 2000 by professional recovery teams, assisted by LANL worker volunteers. About 23 tons (21 metric tons [t]) of seed were used. The types of seed used included native and other species; the BAER Team-recommended seed mix was used extensively in aerial and hand seeding efforts. This seed mix was composed of 30 percent annual ryegrass (*Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot), 10 percent cereal barley (*Hordeum vulgare* L.), 30 percent mountain brome (*Bromus marginatus* Nees ex Steud.), and 30 percent slender wheatgrass (*Elymus trachycaulus* [Link] Gould ex Shinners). The brome and wheatgrass are species native to Los Alamos County. Aerial seeding was performed to achieve a rate of 50 live seeds per square foot of space. Airplanes performing aerial seeding procedure used the Los Alamos and Santa Fe Airports for staging and refueling.

From late June to mid-August 2000, hydromulching was applied to steep, severely burned slopes. Hydromulching consists of spraying a mix composed of straw or wood fiber, organic tackifier (such as a simple cellulose solution), and seed from small low-flying aircraft or truck-mounted equipment (Photo 2.9). Mulch is used to help keep soil in place and to increase the chances that seeds will germinate. It is typically applied at about 2,000 pounds per ac. The aircraft performing hydromulching used Los Alamos Airport for staging, refueling, and loading hydromulch. The aircraft averaged 200 drops per day and covered about 150 ac (60 ha); the truck-mounted hydromulching was primarily used around PRSs. About 175 tons (157.5 t) of hydromulch was applied.

PHOTO 2.9—*Spraying Hydromulch*

Temporary erosion control measures were installed at many scattered locations within LANL (see Figure 2.3, page 2-13). Measures included contour tree felling (Photo 2.10) over about 750 ac (300 ha), installation of on-grade rock and log check dams (Photo 2.11), placement of erosion control jute matting, and placement of straw bales (about 3,200 bales) and wattles (about 125,000 linear feet [37,500 m]) (Photo 2.12). Equipment used to install these control measures included chain saws, shovels, rakes, all-terrain vehicles, bulldozers, and water trucks. About 1,000 ac (400 ha) of land within the boundaries of LANL were treated with these various erosion control measures. Ground disturbance was limited to areas directly around the erosion control measures' installation sites.

PHOTO 2.12—Straw Wattles in Severely Burned Area

The installation or replacement of similar storm water control measures, known as best management practices (BMPs), were required to protect 91 PRSs that had been burned (Figure 2.4, Table 2.4) from soil erosion and storm water runoff in many areas (Table 2.4). In addition to the 91 PRSs requiring BMPs, 77 PRSs located within floodplain or drainage areas (Table 2.5) were evaluated for accelerated cleanup actions. About 47 of these 77 PRSs required accelerated cleanup or other actions, such as sampling or stabilization. As part of this effort, two areas were provided at TA-6 and TA-63 to stage equipment and supplies such as straw bales and wattles, jute fabric, silt fencing materials, and staking materials. Soil disturbance was limited to the immediate vicinity of the BMP installation sites. Damaged, dying, or dead trees near drainages and live and dead trees at construction sites were cut and removed. This resulted in some localized soil disturbance.

Clean-out Activities

Culvert and drainage area clean-out activities were performed at all of the low-lying areas at LANL where storm water runoff was expected and where debris damming might cause storm water to pond. Ponding could result in soil saturation, which could in turn result in roadbed failure. Generally, hand tools or small back-hoe machines were used to remove any obstructions, including tree limbs, brush, leaves, and silt deposits from existing culverts and drainages. Wash out areas around culverts and in drainages were also repaired by addition of rock gabions (a box formed from chain-link mesh, filled with stones, placed in drainage channels, and used for flood and erosion control), soil, or concrete material. This repair work was done as necessary to protect these areas from storm water damage. Some temporary soil-disturbing activities included blading access roads to enable machinery and workers to reach some of the culverts and drainage areas.

TABLE 2.4—*91 PRSs Affected by Fire*

TA	PRS #s	Watershed	HSWA*	BMPs**	Acres/Hectares
49	49-001(g)	Water Canyon	X	A,K	2/.80
48	48-007(f)	Mortandad Canyon	X	A,B	0.5/0.2
	48-007(b,c)		X	A,B,D,E	0.5/0.2
	48-003		X	A,B,D	0.5/0.2
46	46-004 (f-h,m,q-z)	Cañada del Buey	X	A,B,E,J,G	17/6.8
	46-004 (a-c2)		X		
42	42-004	Cañon de Valle	-	A,B	1/0.4
40	40-009,010	Pajarito Canyon	X	B,C,L	4/1.6
	40-006 (b,c)		X	A,B	2/.80
36	C-36-003	Three Mile Canyon	X	B,K	3/1.2
22	22-015(c)	Pajarito Canyon	X	A,B	2/.80
16	16-030(h)	Water Canyon	X	A,B	0.5/0.2
	16-029(g)		X		0.5/0.2
	16-028(a,b)		X		1/0.4
	16-026(h2)		X		0.5/0.2
	16-021(c)	Cañon de Valle	X	F,B	1/0.4
	16-020		X	A,B	0.5/0.2
	16-019		X	A,B,D,I	2/.80
	16-018		X	L	1/0.4
	16-016(c)		X		
	16-004(f)	Water Canyon	X	A,B	0.5/0.2
	16-003(n,o)	Cañon de Valle	X	A,B	0.5/0.2
	16-003 (a,f)	Water Canyon	X	A,B	1/0.4
15	15-011(a,b,c,)	Cañon de Valle	X	B,C	0.5/0.2
	15-014 (i,j,k)		X		
	C-15-007, 010		-		
	15-007(b)		X	A,B	0.5/0.2
	15-006(c)	Three Mile Canyon	X	A,B,C,F,K	25/10
	15-008(b)		X		
14	14-009	Cañon de Valle	X	A,B,D,F	2/.80
	14-006		X	A,B	1/0.4
	14-002(c,d,e)		X	A,B	1/0.4
	14-002(a),		X	A,B,F	6/2.4
	14-010		X		
11	11-006(a,b,c,d)	Water Canyon	X	H,G	10/4
	11-004(a-f)		X		
9	09-013	Cañon de Valle	X	A,C,E,K	5/2
	09-009		X	A,B	2/.80
	09-004(a,n,o)		X		2/.80
6	06-007(g)	Two Mile Canyon	X	A,B	0.5/0.2
5	05-006(b,c,e,h)	Mortandad Canyon	X	A,B,C	15/6
	05-005(a,b)		X	A,B,C	15/6
	05-003, 004		X	A,B	4.5/1.8
	05-001(a,b)		X	A,B,C	15/6
4	04-003(b)		X	A,B	2.5/1
	04-001, 002		X		
TOTAL	91				Approximately 142 ac/57 ha

- = No Action, *HSWA = (RCRA) Hazardous and Solid Waste Amendments apply
**BMPs = A-raking, seeding, mulching; B-straw wattles; C-low flow silt dikes; D-riprap; E-earthen berms; F-rock check dam; G-hydromulch; H-log check dam; I-concrete barriers; J-tree felling; K-low flow silt fence; L-earthen/rock diversion structure

TABLE 2.5—*Floodplain PRSs: Status of Accelerated Actions as of August 24, 2000*

Watershed	#PRSs	Accelerated actions in process*	Recommended for corrective action	Corrective action complete	No immediate action required
Los Alamos Canyon Watershed					
TA-2	34	23	4	4	3
TA-41	6	6			
Los Alamos Canyon	1			1	
Pueblo Canyon	1				1
Pajarito Canyon Watershed					
TA-18	29	6			23
TA-27	1				1
Pajarito Canyon	1	1			
Other Watersheds					
Mortandad Canyon	2			1**	1
Water Canyon	2				2
Total	77	36	4	6	31

* Accelerated actions include additional site characterization or protective measures.
** Mortandad Canyon sediment traps.

Damage Reduction

Various flood damage control measures were installed to provide protection to electric power pole structures and other utility structures (such as electric substations, gas lines, water lines, wells and chlorination stations, sewage lift stations, and telephone and communication structures) (Photo 2.13). These measures included sandbags, concrete barriers, rock gabions (Photo 2.14), straw bales and wattles, and silt fences. Some electrical conduits and potable water and sewage waste distribution lines were moved, re-routed, or reinforced to ensure their continued integrity.

Radioactive and hazardous materials and waste were removed from TA-2, TA-41, and TA-18 to eliminate the possibility of their being transported downstream in storm water runoff. For the most part, containers were relocated to higher ground within the same TA where they were located. Other LANL sites were used to store these materials and waste as appropriate.

PHOTO 2.13—*Storm Water Protection around Utility Pole*

PHOTO 2.14—*Multiple Rock Gabions being Assembled at Los Alamos Canyon Weir*

2.3.2 Watershed-specific Post-fire Activities

Some post-fire activities that are described in the previous section (2.3.1) resulted in ground disturbance within certain watersheds. In addition, USACE projects to control storm water runoff and reduce flood hazards were constructed within these watersheds in both burned and unburned areas. Removal of contaminated soils and other sediments was also conducted within these watersheds. The activities described in this section were both small and large in relative scale. The direct and indirect impacts of the activities are not necessarily limited to the areas immediately in the vicinity of the action itself. The activities were almost all ground disturbing; however, some activities occurred in areas that had been previously disturbed and developed, while others were conducted at areas that had not been overtly disturbed or developed. Constructed erosion and water control devices and structures using rock and concrete materials are expected to remain in place for three to perhaps as many as ten years. Organic materials used for erosion control and storm water control purposes are expected to gradually decay in place over the next few years.

USACE undertook seven post-fire construction actions according to stringent DOE and USACE design and construction requirements (LANL 2000a). Various material, work practices, and regulatory compliance standards were applied to the construction actions as well. Engineering assessments of various kinds were performed at each construction site. Core drilling was conducted to investigate soil properties for designing flood control structures. The USACE projects implemented are summarized in Table 2.6, and their locations are shown in Figure 2.5. Please note that Figure 1.4 (see page 1-15) identifies technical areas at LANL referenced later in the text. The following sections describe

TABLE 2.6—*U.S. Army Corps of Engineers Fire Rehabilitation Actions*

Title	Task Description	Areas Impacted and dimensions	Area Impacted (ac/ha)
Weir and Sediment Trap in Los Alamos Canyon	Construct a rock gabion low-head weir structure in Los Alamos Canyon above the SR 4 intersection with SR 502. The weir will be 10 ft (3 m) above grade and located on the downstream side of an excavated short-term detention basin to prevent sediments from migrating off LANL property. Excavated soil will be piled and sloped on the western side of the detention basin.	Detention Basin: 10 ft (3 m) high by 500 ft (152 m) long by 100 ft (30.5 m) wide Excavated backfill: 30 ft (9.1 m) high by 27,000 square feet (ft^2) (2,508 square meters [m^2]) 30 ft (9.1 m) high by 31,500 ft^2 (2,926 m^2)	1.1/0.45 0.62/0.25 0.72/0.29
Reinforce Los Alamos Reservoir	Reinforce the existing embankment at the LA reservoir by installing an articulated concrete mattress (ACM) over the upstream face top and the downstream embankment of the dam. Build a 300-ft (90-m) long access road downstream of the reservoir.	ACM area: 200 ft (60 m) by 200 ft (60 m) Road: 300 ft (91 m) by 10 ft (3 m)	1.0/0.40 0.07/0.03
Pajarito Canyon Flood Retention Structure	Design and construct a concrete structure in Pajarito Canyon, approximately 2.0 miles (mi) (3.2 kilometers [km]) upstream of TA-18, to retain water and prevent potential downstream flooding at TA-18 and in White Rock. The flood retention structure design specifies the structure to be approximately 70 ft (21 m) above grade and 390 ft (117 m) across the width of Pajarito Canyon. The bottom of the structure will have a 42-inch (in.) (105-centimeter [cm]), non-gated drainage conduit. Normal rainfall amounts will flow through. Accumulations of water shall be retained for no longer than 96 hours and will drain naturally into existing streambeds.	Construction zone: 800 ft (244 m) by 500 ft (152 m) Staging areas: with batch plant 300 ft (90 m) by 300 ft (90 m) and 200 ft (60 m) by 300 ft (90 m)	9.2/3.7 2.1/.84 1.38/.55
Reinforce SR 501 Crossing at Pajarito Canyon	Grade and shape the downstream slope of SR 501 and place 6-in. (15-cm) thick shotcrete mattress for a distance of approximately 200 ft (60 m).	ACM area: 50 ft (15 m) by 200 ft (60 m)	<0.5/<0.2
Reinforce SR 501 Crossing at Two Mile Canyon	Grade and shape the downstream slope of SR 501 and place 6-in. (15-cm) thick shotcrete mattress for a distance of approximately 200 ft (60 m). Place reinforcement matting for a distance of approximately 260 ft (78 m) adjacent to the shotcrete mattress.	ACM area: 50 ft (15 m) by 200 ft (60 m) Shotcrete: 50 ft (15 m) by 260 ft (78 m)	<0.5/<0.2
Reinforce Anchor Ranch Road Crossing at Two Mile Canyon	Reinforce both the upstream and downstream slopes of Two Mile Canyon at the Anchor Ranch Road land bridge. Construct an emergency spillway to the south of the embankment. Modify the downstream slope to approximately a two-to-one slope.	ACM area: 100 ft (30 m) by 340 ft (115 m)	<1.0/<0.4
Reinforce SR 501 at Water Canyon	Temporarily place six ACMs on filter fabric in severely washed out areas downstream of the embankment slope. Grade and shape the upstream and downstream slopes of SR 501, relocates previously placed ACM from the downstream slope to the upstream slope, and place shotcrete on the downstream slope for a distance of approximately 256 ft (76.8 m).	ACM and shotcrete area: 100 ft (30 m) by 200 ft (60 m)	<1.0/<0.4

activities in the Los Alamos Canyon watershed, the Pajarito Canyon watershed, and the other watersheds at LANL as described in Table 2.1 (see page 2-4).

2.3.2.1 Los Alamos Canyon Watershed

The activities described below occurred in Los Alamos Canyon. Other canyons within this watershed may have been subject to non-DOE rehabilitation activities, such as the installation of stream wattles and rock check dams, conducted by the Forest Service or the County of Los Alamos.

Removal of Structures from Floodplain

Some structures were removed from their canyon bottom locations to eliminate the possibility either that storm water runoff would transport radioactive or hazardous contaminants downstream or that these structures might become part of the debris load moving downstream in the event of a flood. The Los Alamos Canyon structures removed for this latter reason were abandoned structures at TA-2 already slated for demolition. To take action to protect them from the potential effects of a major flood event was considered not to be fiscally prudent. At TA-2, several structures were removed including the cooling tower (TA-2-49) and attached structure (TA-2-57), an underground pump station (TA-2-53)and three underground storage tanks (TA-2-54, 55, and 56) (1,200 gal. [4,548 l] each), a small masonry building used for storing radioactive materials and samples (the rod storage facility TA-2-4), a surge tank (TA-2-46), a storage building (TA-2-88), and a guard station (TA-2-69). Another storage structure (TA-2-50) was decontaminated but not demolished. Heavy machinery was used to demolish the structures and remove the resulting waste. Waste generated during the demolition, including contaminated soils, was transported to LANL's TA-54 for disposal.

Storm Water Controls

Sandbags, shielding blocks, and concrete barriers were placed at various locations at TA-2 and TA-41 to prevent damage to remaining structures in Los Alamos Canyon. Rock gabions were also installed to reduce storm water runoff acceleration at various strategic locations.

Diversion structures and BMPs were also installed to prevent erosion of material around the radioactive liquid waste (RLW) cross-facility pipeline located in Los Alamos Canyon at TA-2.

The existing unpaved road that traverses the lower portion of Los Alamos Canyon was regraded to accommodate heavy machinery transport. Rock gabions were installed as needed for erosion control along this roadway. A new road was bladed between the east fence at TA-41 and the TA-41-56 sewage lift station, around which BMPs were installed. Some of the security fencing at TA-41 and TA-2 was removed near the construction area but has been replaced.

Storm Water and Sediment Retention

At the upper end of Los Alamos Canyon, the Los Alamos Reservoir was drained to serve as a catchment for storm water and sediment and to facilitate strengthening the dam. Before strengthening the dam, cores were drilled at the top of the dam, and a new 300-ft (90-m) temporary road was constructed from the downstream slope of the dam to an existing camping area to facilitate equipment access. The pedestrian walkway over the reservoir dam was removed. The reservoir dam faces were strengthened to lessen the danger of dam failure so that the dam can trap water and debris from the heavily burned area of the watershed upstream from the reservoir. An ACM was installed as reinforcement over the upstream face, top, and downstream embankment of the dam (Photo 2.15). Shotcrete (blown concrete) was then placed over all faces of the dam. Downstream, a debris catcher was constructed in Los Alamos Canyon above the Los Alamos Ice Skating Rink. This debris catcher (also known as a "trash rack") (Photo 2.16) was constructed of metal bars and braces. It was designed to catch trees and other floating debris in the event of a flood. Another debris catcher was constructed about 500 ft (150 m) west of TA-41.

PHOTO 2.15—*Reinforcing Los Alamos Reservoir*

PHOTO 2.16—*Debris Catcher or "Trash Rack"*

A low-head weir and sediment trap was constructed in Los Alamos Canyon near the intersection of SR 4 and SR 501 within TA-72 to provide sediment control and retention and deceleration of storm water flow. The weir includes a large, relatively shallow basin that will serve as a sedimentation basin and sediment retention structure. The detention basin is 500 ft (150 m) long by 100 ft (30 m) wide by 10 ft (3 m) deep.

The weir is located on the downstream side of the detention basin and is about 10 ft (3 m) above grade. It is constructed of rock gabions (Photo 2.17). The total area affected, including the weir, detention basin, and excavated backfill area, is less than 3 ac (1.2 ha). Approximately 11,900 cubic yards (yd^3) (9,044 cubic meters [m^3]) of soil and rock were excavated and banked along the sides of the canyon.

Contaminant Removal

Approximately 915 yd^3 (700 m^3) of contaminated surface silt and soil were removed from a 2.5-ac (1.0-ha) site in Los Alamos Canyon east of the confluence of Los Alamos Canyon and DP Canyon, during June 2000. The soil was removed to minimize the overall potential for migration of contaminants in the event of a severe flood. The removed sediment contained low levels of radioactive contaminants from LANL operations in the 1940s and 1950s at a concentration of about 20 times greater than natural sediment deposits within Los Alamos Canyon. Heavy excavation and hauling equipment, such as a backhoe, excavator, and dump truck, was used to remove the soil. The contaminated soil was transported by truck and disposed of at TA-54, Area G.

PHOTO 2.17—*Los Alamos Canyon Weir Near SR 4 Under Construction*

Other Measures

Fences were erected in Los Alamos Canyon near the Diamond Drive bridge (also known as the Omega Bridge) to keep the public out of the TA-41 and TA-2 construction areas. These fences were designed with gates that would be opened in the event of a flood event.

2.3.2.2 Pajarito Canyon Watershed

Except for reinforcements of SR 501 and Anchor Ranch Road at canyon crossings, activities in the Pajarito Canyon watershed were conducted at TA-18 or just upstream from TA-18 near the junction of Pajarito and Two Mile Canyons.

Road Reinforcements

At Anchor Ranch Road, a test pit (about 6 ft long by 2 ft wide by 8 ft deep [1.8 m by 0.6 m by 2.4 m]) was excavated west (upstream) of the existing inlet for the Anchor Ranch Road land bridge across Two Mile Canyon to characterize the road foundation material. The embankment at this crossing and the embankments where SR 501 crosses Two Mile Canyon and Pajarito Canyon were reinforced with concrete to protect the road beds from becoming saturated and failing. Existing ACMs and matting were removed as necessary, along with trees on or near highway embankment slopes. The slopes were then cleared, tree roots and rocks were removed, and the area was regraded (additional fill soil was added as needed). Trenches, as necessary, were excavated at all embankments. Embankments were reinforced with soil nails (shafts drilled into the embankment and pressure grouted) ACMs, and/or shotcrete (a concrete mix blown onto surfaces) (Photo 2.18). A spillway coated with shotcrete was incorporated into the design and construction of the Anchor Ranch Road land bridge site at Pajarito Canyon. Outlet structures were also incorporated into the design and construction of all three canyon crossing road locations so that water would not pond behind the roadbeds for more than four days (96 hours) after a storm event.

PHOTO 2.18—*ACMs Used to Reinforce Road*

Flood Retention Structure

In early June 2000, a temporary earthen berm was constructed immediately upstream from the TA-18 facilities in Pajarito Canyon to serve as a storm water and debris retention structure. This structure was removed after construction of the large concrete flood and retention structure further upstream was started.

A new roller-compacted concrete flood and sediment retention structure in Pajarito Canyon above TA-18 (Photo 2.19) was installed to control storm water flooding and runoff down the canyon into TA-18 and into the White Rock residential area. Trees were removed from the construction area in the canyon bottom, and the area was graded in preparation for core drilling and construction. The existing road along the south side of Pajarito Road was graded and widened to accommodate construction trucks and vehicles. A new road was constructed to accommodate the heavy concrete equipment needed for construction of the structure itself. This road is about 25 ft (7.5 m) wide and less than 0.25 mi (0.4 km) in length. An existing road up Pajarito Canyon from TA-18 was regraded and improved for construction use on this project as well. Core drilling was performed and the resulting data were used, along with other information, to determine the size of the finished structure. The area cleared for the flood retention structure and

PHOTO 2.19—*Base of Flood Retention Structure in Pajarito Canyon Under Construction*

equipment staging and operations was about 800 ft (240 m) long by 500 ft (150 m) wide, totaling about 10 ac (4 ha). The structure extends 390 ft (117 m) across the canyon and is about 70 ft (21 m) high. The bottom of the retention structure is equipped with one 42-in.- (105-cm-) diameter drainage conduit, which will allow accumulated storm water to exit. Accumulated water will be retained no longer than 96 hours; water will drain naturally into the existing streambed. Soil was backpiled on the upstream side of the retention structure to provide additional structural strength. Soil was later regraded and placed against the sides of the canyon. Construction of the flood retention structure was conducted over about a six-week time period from July to late August 2000.

Two staging areas were used for construction equipment and lay-down sites: one was located directly off Pajarito Road, southeast of TA-66-1, and the other was located on the first bench of the canyon. The sizes of staging areas were about 300 ft by 300 ft (90 m by 90 m) and 200 ft by 300 ft (60 m by 90 m), respectively. These staging areas required site clearing. A concrete pad was constructed at the first bench site to accommodate the concrete batch plant construction. A 38- to 46-in.-diameter (95- to 115-cm) plastic pipe was extended off the mesa top from the batch plant; the pipe was intended to move aggregate down to the lower staging area, where the aggregate was to be mixed with water. The mixture would then have flowed down the pipe to the retention structure construction site. However, this system did not function properly and it was necessary to move the concrete by truck down the canyon to the retention structure construction site. Four concrete trucks were used, and about 400 trips per day for three weeks were required to complete the job. Two generators and light towers were used at the site. Construction was conducted 24 hours a day for the duration of the 60-day construction period.

Steel Diversion Wall

A 760-ft-long (228-m) steel diversion wall was constructed upstream of TA-18 in Pajarito Canyon (Photo 2.20). The wall will divert storm water and debris to the south of critical assembly building 1 (Kiva 1) at TA-18. Approximately 1,000 ft (300 m) of steel panels attached to large metal beams (Photo 2.21) were installed. The beams were driven vertically into the ground with a vibratory hammer. The sheets extended approximately 5 ft to 6 ft (1.5 m to 1.8 m) aboveground. Sheet piling was initiated in early July and completed in about three weeks. The structure was backfilled with earth to provide additional strength on the downstream side.

PHOTO 2.20—*Steel Diversion Wall at TA-18 Under Construction*

PHOTO 2.21—*Detail of Joined Steel Panel*

Other Activities at TA-18

The existing streambed located south of Kiva 1 in Pajarito Canyon was straightened, deepened, and widened approximately 10 to 15 ft (3 to 4.5 m) to create a larger drainage channel. About 1,600 ft (480 m) of channel was graded and scraped. The foot bridge that spanned the original drainage area was removed.

A "natural trash rack," or debris catcher, was also created above TA-18 in Pajarito Canyon for about one mile (1.6 km) by cutting burned and dead or dying trees within about 3 ft to 4 ft (0.9 m to 1.2 m) abovegrade. The tree tops and limbs were removed from the site using trucks. This action was conducted in June 2000 over about a two-week period. A debris catcher constructed of metal braces and bars was also installed at the upstream edge of the TA-18 facility (Photo 2.22). Both of these trash racks are designed to catch and hold back debris, such as logs and heavy rocks, that might be moved by floodwaters. The trash racks would therefore provide a protective measure to the TA-18 facilities against debris bombardment in the event of a flood.

PHOTO 2.22—*Trash Rack above TA-18 with Steel Diversion Wall in Background*

Additional activities were conducted at TA-18 that did not involve soil disturbance. These activities included moving on-site radioactive materials around the TA-18 facilities to maximize protection from storm water flooding conditions and moving nonessential employees to other LANL locations.

Culvert Replacement at SR 4

In June 2000, DOE allowed the New Mexico State Highway Department to use an area of TA-36 next to the intersection of Pajarito Road and SR 4 for an equipment and supply staging area. The Highway Department removed existing culverts along SR 4 within the road easement corridor and replaced the culverts with larger ones. As a part of that action the Highway Department removed vegetation surrounding the culvert site within the road easement and at the staging site nearby in Pajarito Canyon.

2.3.2.3 Other Watersheds

Sandia Canyon Watershed

The TA-60 access road into Sandia Canyon was repaired by grading part of the road. Diversion structures and BMPs, primarily rock gabions, were installed around the RLW cross-facility pipeline to prevent soil erosion around that structure within Sandia Canyon at TA-60.

Mortandad Canyon Watershed

The activities described below were located within Mortandad Canyon and Cañada del Buey. No watershed-specific activities were undertaken in Ten-Site Canyon. The access road into Mortandad Canyon was repaired by regrading it. Using this road, about 350 yd^3 (266 m^3) of sediment were removed from the three existing sediment traps in Mortandad Canyon during July 2000. The purpose of this maintenance action was to increase the capacity of the existing traps in case of flooding during an extreme rain event and to prevent the sediments from migrating off site. The traps were constructed in 1986 and consist of large excavated basins surrounded by U-shaped berms that were built from the excavated alluvium; the traps have not been cleaned since 1992. The traps are approximately 900 ft (270 m) long and a maximum of 200 ft (60 m) wide and are located along the Mortandad Canyon stream channel downstream from the confluence of Mortandad Canyon and Ten-Site Canyon. The total capacity of the sediment traps is about 1.2 million gal. (4.5 million l). The sediments were excavated using heavy equipment and silt was placed onto flatbed trucks and removed from the site to LANL's low-level waste disposal site at TA-54.

The existing roadway within Cañada del Buey was bermed to provide outfall drainage control. The storm water drainage outfall location for TA-54 was also recontoured within this canyon. A bulldozer was used to perform both of these soil-disturbing activities.

Water Canyon Watershed

The activities described below occurred in Water Canyon. No watershed-specific post-fire activities were undertaken in Cañon de Valle, Potrillo Canyon, or Fence Canyon.

Erosion and flood control structures were constructed along SR 501 at the Water Canyon crossing area. At this location, the road embankment was reinforced with shotcrete, which will serve to keep the road bank from becoming saturated and failing. The road embankments and culverts will act as a flow control structure, slowing storm water runoff into the canyon. Existing ACMs and reinforcement matting were removed, along with trees on or near highway embankment slopes. The embankments were then cleared, tree roots and rocks were removed, and the area was regraded. Trenches were excavated at all embankments. The embankments were reinforced with ACMs, soil nails, and shotcrete as needed.

BMPs were installed at the MDA-R site, which was partially excavated to suppress a subterranean fire at that disposal site. These BMPs will protect the remaining waste from runon and runoff, as well as the pit formed when a portion of MDA-R was excavated.

2.4 Mitigation Measures

Mitigation measures were and will be implemented for actions described throughout Section 2.1. These mitigation measures are designed to

- minimize the potential for long-term significant impacts associated with specific response actions,
- minimize the cumulative effects of regional response actions,
- optimize the maintenance and function of response structures and actions, and
- contribute to the long-term fire recovery process.

These mitigation measures are part of the actions DOE will take to maintain response action structures and other initiatives. Some of these mitigation measures collectively provide the basis for site-wide mitigation as part of the Cerro Grande Fire SWPP Plan and are included in the *Clean Water Act* Section 404 Permit. The specific location and type of mitigation actions vary throughout the watersheds of the ROI but may be generally categorized under the headings of resource management mitigations.

The following describes the scope of mitigation measures:

- Monitoring, recontouring, and reseeding with site-specific seed mixtures at construction areas (that were previously seeded at the end of the construction activity) will be performed as needed until the construction sites have been completely revegetated.

- Restored burned areas that have been reseeded, as well as other erosion hazard reduction actions, will be monitored annually for the next five years (through 2005). Repair, replacement, or repetition of these actions will be undertaken as needed until at least 90 percent revegetation is achieved or until post-fire storm event flows approximate pre-fire flow rates according to modeling and monitoring results.

- Removal of the constructed flood control and erosion damage reduction features and the flood retention structure when storm water flows have returned to pre-fire levels as denoted by vegetation recovery and annual modeling estimates will be considered. Additional NEPA and other regulatory compliance would be necessary when these actions become ripe for consideration. If the structures are removed, recontouring and reseeding of these areas with appropriate site-specific seed mixtures would be conducted until these construction sites have been completely revegetated.

- Assessments and reevaluations of management plans for various natural and cultural resources within LANL will be undertaken and implemented as appropriate. These plans include the recently implemented LANL Threatened and Endangered Species Habitat Management Plan.